MDE Product Development Team
March FY14 2nd Quarterly Report
Submitted 15 April 2014

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*(Compiled and edited by **S. Benjamin** and **B. Johnson**)*

Executive Summary

Task 1: Improve turbulence guidance from NWP forecasts from RAP, NAM, others

- **RAPv2 became operational at NCEP at 12z Tuesday 25 February 2014; transition from RAPv1 went smoothly (see http://rapidrefresh.noaa.gov)**
- RAPv2 webinar given to NWS forecasters in February (at 2 different times) - **http://ruc.noaa.gov/pdf/RAPv2-NWSwebinar-18feb2014-FINAL.pdf**
- RAP/HRRR presentation at December 2013 annual NCEP Model Production Suite Review, available at **http://ruc.noaa.gov/pdf/NCEP_PSR_2013_RAP_FINAL_v5.pdf**
- Three real-time parallel RAP cycles (with extensive verification of each toward RAPv3) running on Zeus to evaluate further likely enhancements to RAP assimilation/model system for spring 2014 code freeze and to be implemented at NCEP in 2015.
- Likely near-final RAPv3 analysis, model and post-processing configuration now running in RAP-primary at GSD since 12 March 2014.
- RAPv3 giving greater weight to ensemble covariances in GSI ensemble-hybrid analysis, use of background 2-m forecast dewpoint and temperature instead of 8m, WRFv3.5.1 model code with upgrades to RRTMG radiation, RUC LSM upgrades, further modification to MYNN surface layer and PBL, Grell-Freitas deep and shallow convection and v3.5.1 Thompson microphysics, as well as enhancements to post-processing.
- NCEP making continued progress on NAM and NAM-nest

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- Finalized a comprehensive set of upgrades to the GSD real-time experimental HRRR and froze them for the 2014 warm season evaluation, following those performed for the RAP under Task 1.
- Encouraging results seen in recent convective forecasts from frozen version of RAP / HRRR system.
- Continued good progress toward the HRRR operational implementation at NCEP (scheduled for 19 Aug. 2014), including run-time improvements. Recent work focusing on conversion of control scripts to NCO workflow.

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- Improved WRFv3.4.1 version of Thompson mixed-phase cloud microphysics scheme implemented into RAPv2 at NCEP (25 Feb) and WRFv3.5.1 version into RAPv3 and HRRR at ESRL (March-April)
- Latest version of Grell-Freitas cumulus scheme in RAP deemed fit to replace old G3 scheme for RAPv3.
- RAP-primary and RAP-dev cycles now all running with likely RAPv3 physics configuration.
- Good progress in substantially reducing cold nighttime bias over snow cover Implementation of this physics configuration in RAP-primary 12 March 2014; expected in RAPv3 at NCEP starting in 2015.
- RAPv2 updated physics configuration including updated Thompson cloud microphysics, and MYNN-Olson boundary-layer mixing (better winds near surface including terminals) running operationally at NCEP as part of the 25 February 2014 implementation.

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

- Real-time, frozen RAPv2 (matching NCEP RAPv2)/HRRR system continues to run successfully with gridded field dissemination into winter 2013-14 although CoSPA officially shut down on 1 Nov 2013.
- HRRR “failover” capability to use feed from Zeus instead of Jet during Jet downtime continued to work.
- GSD plans for HRRRv2 follows physics changes for RAPv3, and a plan to be implemented on Jet and Zeus by early April 2014 and at NCEP in 2015.

Task 1: Improve turbulence guidance from NWP forecasts

Improving turbulence forecast quality involves efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM Nest models) and to improve the models (WRF-Advanced Research WRF (ARW)-RAP and NOAA Environmental Modeling System (NEMS)- Nonhydrostatic Multi-scale Model – B (NMMB)).
Tasks will include:

- Continuing evaluation of RAPv2 toward early 2014 implementation at NCEP, incorporating changes developed in 2012 and early 2013
- Development of RAPv3 toward 2015 implementation at ESRL and subsequent implementation at NCEP
- Collaborating on developing and testing best approaches for use of hybrid/EnKF/3DVAR data assimilation within common GSI coding structure.

ESRL

Regarding the operational NCEP RAP

The operational RAP (previously RAPv1) was upgraded to RAPv2 as scheduled at 1200 UTC Tuesday 25 February 2014. The RAPv2 has run well since its implementation except for a minor post-processing error at NCEP that affected the downward shortwave radiation at the surface for CONUS 130 grids only. (An emergency fix for this was made on 20 March.) For all of 2014 prior to the RAPv2 implementation, the RAPv1 ran without any technical problems, including in the post processing.

The RAP web page **http://rapidrefresh.noaa.gov** is updated with information on the operational RAPv2 configuration including a Feb NWS webinar ppt on RAPv2 - **http://ruc.noaa.gov/pdf/RAPv2-NWSwebinar-18feb2014-FINAL.pdf**. A link to the RAPv2 Technical Implementation Notice is there also. A webpage on RAP output grids from NCEP is at **http://ruc.noaa.gov/rr/RAP-NCEP-output-grids.html**.

RAPv3 model testing

Intensive effort by the RAP development team, judicious use of the 3 real-time development cycles on Zeus plus retrospective testing of candidate changes for improved summer performance has produced a RAPv3 configuration that is a significant improvement over RAPv2.

On 12 March the near-final RAPv3 configuration was put into the RAP-primary cycle at GSD, with final changes made 1700 UTC 5 April. A summary has been published on the web at **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf**. The following summarizes major changes from RAPv2 for analysis, model and post-processing for this configuration.

Analysis (data assimilation)

- Gridpoint Statistical Interpolation (GSI) code updated to recent NCEP repository release
- Weighting between the ensemble-derived and static (3dVAR) covariances changed from 50%-50% to 75% ensemble – 25% static in the GSI hybrid-variational analysis. Giving greater weight to the (GFS) ensemble-derived covariances improved performance slightly in the first several hours of the forecast.
- Radiance bias correction is now cycled rather than being specified as a constant (see paragraph on this area regarding GSD effort from Haidao Lin below)
- Three improvements to the GSI cloud / hydrometeor analysis
    - Correction to formula for conservation of virtual potential temperature when cloud added or removed. *This important change came as a result of feedback from the Storm Prediction Center concerning RAP performance on 17 November 2013.*
    - Impose limit of 100% saturation
    - Correct specification of rain-number concentration
- Revised the procedure for obtaining background 2-m mixing ratio for use in computing observation innovations from surface observations in GSI. Formerly, the mixing ratio at midpoint (~ 8m AGL) of the lowest model layer is being used. But, since the mixing ratio at 2m is typically higher than that at 8m during the daytime, this procedure (together with our procedure for spreading the surface observation innovations vertically when the background 1-h forecast has a mixed layer) appeared to be systematically moistening the atmosphere in the daytime mixed layer. Usage of a weighted average of the diagnosed 2-m mixing ratio and the explicitly predicted lowest-model-

layer mixing ratio (2/3 for 2m and 1/3 for ~8m) rather than the lowest-model-layer mixing ratio alone showed lessening of the low level moist bias as verified against radiosondes. This is an important change because it has impact not only at the surface but also in the lower troposphere, where it will impact the forecast of the environment of convection.
- Snow building / trimming updated to add snow over generally smaller areas, but in larger amounts where it is added, based on IMS snow and ice analysis. Ensure skin temperature and temperature in snow is ≤ 272K wherever snow is added.

Model

- Update to WRFv3.5.1 from 3.4.1. This includes a revised version of the Thompson microphysics. The v3.5.1 versions of the MYNN PBL and the RUC LSM have received further upgrades as discussed here and under Task 3.
- Switch from Goddard short wave and RRTM long-wave radiation to RRTMG for both short and long wave, and reduce frequency of calls to radiation to once every 20min from every 10min. (see Task 3).
- Enabled "swint" option to recompute solar radiation based on current-forecast-time solar zenith angle at time steps when short-wave radiation not called.
- RUC LSM upgrades for improved treatment of albedo over partial snow cover as well as other details in treatment of snow (Task 3).
- Use of new MODIS greenness fraction and Leaf-Area Index (LAI) fields in RUC LSM (see Task 3).
- Replace the Grell WRFv3.2.1 G3 deep and shallow cumulus scheme by the Grell-Freitas (G-F) deep and shallow cumulus scheme with radiation feedback (see Task 3).
- Updates to mitigate cold bias over snow (see Task 3)
    - Increased thickness of top snow layer in RUC LSM
    - Reduced assumed value of exchange coefficient under stable stratification when 2-m temperature and mixing ratio are diagnosed from values at lowest model level (~ 8m).
    - Decrease of thermal roughness length over snow under very stable conditions in MYNN surface-layer scheme.
- Various changes to MYNN PBL scheme to address tendency for warm bias at the surface during afternoon and evening during warm season (discussed in past MDE reports) and to improve coupling with G-F shallow cumulus scheme.
- Switch to hypsometric_opt = 2 in model namelist, together with NCAR bug fix in for this option (see FY2014Q1 MDE report for more details on this change, which was introduced to prevent occasional crashing along lateral boundaries.)
- Removal of the terrain modifications near the lateral boundaries (including Greenland) introduced in late 2013, and introduction of the blended WPS geogrid terrain option (WRF terrain blended with external model: in the case of RAP this is the GFS) near the boundaries.

Post-processing

- Added Direct Normal Incident solar radiation and whole-sky diffuse solar radiation to model output.
- Added capability to output 2-m dew point diagnosed from lowest model layer dew point and surface latent-heat flux.
- Introduced check to ensure that output 2-m dew point is not higher than output 2-m temperature.
- Relaxed restriction on ice pellets at lowest model level in precipitation-type algorithm (allows greater areal coverage of ice-pellet precipitation type in output precipitation-type fields).
- Bug fixes for binary I/O, very small hydrometeor mixing ratios, and for small differences between lowest two model layer-interface pressures.
- Proper calculation of 0-h 1km AGL and 4km AGL reflectivity.

Changes that were under serious consideration for RAPv3, but in the end were judged unlikely to improve skill or needed further vetting include

- Cloud building up to 3000m AGL (from up to 1200m currently) in GSI cloud analysis based on GOES data
- Use of new radar mask to more accurately identifies volumes of atmosphere that are not monitored by radar due to beam blockage by terrain (see MDE January 2014 monthly report).

An initial RAPv3 testing report is available at **http://ruc.noaa.gov/faa-mde/RAPv3-evaluation-15feb2014.pdf**

Again, a full summary of RAPv3 changes is available at http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf

NARRE planning:
More discussions occurred between GSD and EMC staff on planning for the NARRE. An updated MDE plan presented to the Numerical Modeling Strategic Planning Team (FAA) included this information. This information is summarized in a report in **http://ruc.noaa.gov/pdf/Benj_DTC_RAP-NARRE-Apr14.pdf**

Ensemble data assimilation report.
This deliverable and progress up to this point is summarized in this presentation by Ming Hu from GSD:
http://ruc.noaa.gov/pdf/WoF_RAP_hyb_01April2014_Hu.pdf

Satellite radiance assimilation:
GSD (Haidao Lin) has carried out a significant study on the impact of radiance bias correction for the Rapid Refresh. This change has been implemented into the ESRL RAPv3 and allows RAP to use satellite radiances more effectively by removing any expected biases by tracking previous biases on a channel-by-channel basis.

RAP reports on satellite assimilation using ensemble/hybrid data assimilation (for Deliverable 1.e) are available at:
http://ruc.noaa.gov/pdf/2014_WoF_High_Impact_Weather_Lin_FINAL.pdf and in
http://ruc.noaa.gov/faa-mde/2014_AMS_Lin_EnKF-satellite-assim.pdf

Other activities, some noted more fully under other tasks, also were undertaken:

- Retrospective testing for both RAP and HRRR of the impacts of proprietary in situ tower wind data and other special data under funding from the DOE Wind Forecast Improvement Project was concluded and a report is being written for DOE.
- Discussions with EMC continue concerning the best procedure to ensure that proprietary wind tower and nacelle wind measurements are available to the operational RAP and NAM.
- Quasi-biweekly telecons between GSD and the Storm Prediction Center of NCEP continue to be very beneficial. An example is the 17 November 2013 case noted above.
- Several of GSD's RAP/HRRR developers traveled to Atlanta in early February for the Annual Meeting of the American Meteorological Society. These developers at this collection of meetings presented a total of 17 papers and posters pertaining to the RAP and HRRR.
- During February and March, Stan, Steve Weygandt and Curtis Alexander participated in telecons of FAA's Numerical Modeling Strategic Planning Team. Stan and Geoff DiMego gave presentations at the subsequent NM SPT meeting on 19 Feb, and Stan and others have contributed input to an SPT report.

NCEP

The RAPv2 was successfully implemented at NCEP on 25 Feb 2014.

A RAPV2 bug was found at the beginning of January (in the NCAR code that recomputes heights on the boundaries for the RAP) explained the parallel crashes that occurred in November and December. Making major changes to the parallel was deemed undesirable, so changes made in November and December (to the pressure option of the hypsometric equation as well as modifying the boundary terrain and smoothing the terrain over Greenland) attempting to prevent the crashes were retained. The terrain changes have been removed from RAPv3 per GSD. The parallel RAP with bug fix ran stably in January and February, allowing the Rapid Refresh V2 to be implemented into NCEP Operations at 12Z 25 February 2014. This package, with many improvements to the analysis and model codes, offers significant improvement over V1, and users are now reaping the benefits. The initial HRRR code was delivered to EMC in late January, allowing the testing process to begin. Initial testing in February and March largely involved making a cycle fit within the allocated time window and computing resources. The model forecast has been successfully sped up, and work is now underway to speed up the boundary processing and analysis codes. Other efforts involve determining which parameters will be offered on which grids at which forecast intervals. Implementation is targeted for late August or early September 2014. (Geoff Manikin)

No changes to obs processing for the RAP were made. (Dennis Keyser)

A new module, genex_mod.f90, was created as a straightforward tool to remove the use of full horizontal domain arrays from GSI. Once fully deployed across all components, this will allow the GSI to run efficiently on 1000's of processors for the first time. The first routines to be converted to use genex are two that are used in regional models to convert from

stream and potential function to u and v. One early issue was that results with the new code are not bitwise identical to results with the original code. Wan-Shu Wu tested these new routines on a few 12-hour partial cycles with the NAM NDAS parallel and the differences appear to be reasonable. Note that there is no significant saving of run time or memory with this change in the current RAP & NAM parent runs. It is expected that converting to genex will improve the performance of GSI significantly for the higher resolution CONUS NAM nest and HRRR, and will allow the GSI to keep pace with future resolution increases. (Dave Parrish)

The RTMA/URMA upgrade was implemented on January 28, 2014. Discussions with Professor John Horel from the University of Utah and NWS Western and Eastern Regions were carried out on the issues of quality of first guess and observation QC improvements for RTMA/URMA. The main concern was the systematic rejection of good observations by the gross-error check during valley temperature inversions in the West because of a poor first guess. While improving the first guess is the most appropriate avenue (a blended HRRR/NAMnest based first guess will eventually replace the current RAP-based first guess) an interim solution that relaxes the gross-error check in valleys is now in the parallel RTMA. The GSI code has been enhanced to include a GLERL-type analysis for lake wind observations. This methodology, which adds wind control variables for the water bodies, has also been extended to the other control variables to allow for a better definition of land/water contrasts in the analysis. Work to add a scalar analysis of 10-m wind speed continues. A novel approach to enhancing the terrain following character of the analysis in RTMA/URMA has been proposed. For a given parameter, the method adds a new control variable to analyze the derivative of the parameter's observation with respect to elevation. Work began to downscale the HRRR model forecast to provide the new first guess for CONUS RTMA/URMA. Following NWS-Alaska region's note of the poor quality of RTMA winds over their area's complex terrain, a CALMET-type wind downscaling is now being tested. It is hoped that this method will be able to produce the appropriate along channel first guess winds. A request has been made to MADIS to set up a feed of their time-delayed observation QC for use with URMA. (Manuel Pondeca, Steve Levine, Jim Purser, Jeff McQueen)

The SREF upgrade originally scheduled for March 26 has been delayed for a week to allow for extra WCOSS testing resolving issues found after the first system upgrade since WCOSS went operational in Aug 2013. The new date for implementing the upgraded SREF into NCEP operations is April 2. (Jun Du)

Work began in March to add the upgraded Hiresw WRF runs (scheduled to become operational in June 2014) into the NCEP Convection-Allowing Scale Ensemble. (Binbin Zhou)

The development of an hourly updated version of the NAM known as the NAM-Rapid Refresh (NAMRR) continued on NOAA's R&D machine. The NAMRR configuration includes a 12 km parent and 3 km CONUS nest. The Data Assimilation uses hybrid ensemble-3DVar analysis method. In January the NAMRR was used to help evaluate a microphysics package update intended to improve representation and characterization of deep convective storms. Tests from the NAMRR in a collaborative wind energy data denial project known as POWER (Position of Offshore Wind Energy Resources) were completed in January, and results from the project reported to the Department of Energy along with RAP results by GSD. The NAMRR is undergoing upgrades to make its data assimilation and forecast model consistent with the next NAM implementation. Work was completed in February to enable the initialization of global and regional NMMB ensembles from the global data assimilation system's EnKF members. This is to support the long-term goal of establishing an NMMB-based EnKF as a part of the NARRE/HRRRE. In March a test case covering the May 20th, 2013 Oklahoma severe weather event was conducted and early results from the 3 km CONUSNEST showed substantial improvements in prediction of severe convective storms relative to the operational NAM's 4 km CONUS nest. (Jacob Carley)

The REF2GRB package was upgraded to generate a 3D reflectivity mosaic in grib2 format and being tested. 3D reflectivity product generation with a 15-minute interval is in parallel test. An effort was made to minimize time lag of various situations related to raw data lag or raw data processing lag. Reflectivity mosaic package was modified to generate hybrid scan reflectivity. The new product was compared with composite reflectivity and NSSL’s product. The new product is also in parallel test. Three new BUFR files were added to reflectivity assimilation using GSD’s cloud analysis package. Modifications to GSD’s cloud analysis codes for NMMB added to the GSI and some code details were modified and tested. Cloud analysis codes and scripts were added to the NAM pre-operational parallel. An effort was begun to add cloud analysis codes and scripts to the parallel on the R&D system. Two convinfo files used in GSI for assimilation of reflectivity with and without cloud analysis were combined and tested. Work began in March to improve the Level II radial wind analysis in GSI. (Shun Liu)

A GSI package to be implemented in the operational NAM/NDAS in June was completed and frozen. The scripts were prepared and a bug fixed. The latest bug fixes and a compilation fix were added to the GSI. Adjusting the error variances to eliminate a condition number issue caused by small observational errors solved a convergence problem encountered when testing the regional GSI with just mesonet pressure data. For new types of surface data without valid observational

pressures, methods of locating the data using either station height and/or derived pressure were evaluated and it was decided to use the data with derived pressure. These data were assigned to new types so the data weighting and quality control can be different than the data with good observational pressures. The result was a small but positive impact to the short-term forecasts. The new surface observational types were included in the package to be implemented. (Wan-Shu Wu)

CAPS

In this quarter, while waiting for a user account on ESRL supercomputer Zeus, Gang Zhao of CAPS kept working on NSF supercomputing computer Stampede at TACC. Most efforts were spent on setting up and debugging scripts on Stampede for repeating the dual-resolution hybrid experiments of Yujie Pan, and the results obtained were consistent with those obtained on Zeus. During the Warn-on-Forecast Workshop in Norman, Gang Zhao and Ming Xue of CAPS also further discussed work plan of the next phase with Ming Hu and Stan Benjamin of GSD, for developing an operationally implementable dual-resolution hybrid system for RAP, based on the latest GSI code base, incorporating enhancements made by CAPS. The planned work will start as soon as Zeus account is set up for Gang Zhao. CAPS is also working on direct assimilation of mosaic radar reflectivity data for the target HRRR 3 km resolution and configurations (but initially for a smaller domain), coupled with a radar-assimilating EnKF system run at the same resolution. This effort leverages other sources of support at CAPS. CAPS also revised and resubmitted the dual-resolution MWR paper led by Yujie Pan.

Additional information on RAP-related tasks

ESRL

GSD continues to make pgrb and bgrb files from the ESRL/GSD RAP-primary (RAPv2, but changed to RAPv3 on 12 March) real-time 1-h cycle available from its FTP site for users in NWS and other labs**.**

NCEP

NCEP maintained real-time availability of SAV and AHP guidance to all vendors from the operational hourly RAP on pressure surfaces via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC&NCO)

NCEP maintained real-time availability of full resolution gridded data from the operational RAP runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/rap/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.rap_CY.00 through MT.rap_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.** Gridded RAP and NARRE [-TL] fields are available on **NOMADS** for the CONUS domain on 13 km grid #130 and the Alaska domain on 11.25 km grid #242. RAP fields are also available for the larger North American domain on 32 km grid #221. A limited set of fields from the RAP runs (and other NCEP models) can also be viewed at **http://mag.ncep.noaa.gov**. (EMC&NCO)

Verification of RAP

ESRL's verification of the RAP is available from **http://ruc.noaa.gov/stats**. NCEP maintained its capability and provided access to routine verifications of the operational RAP analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** .

Deliverables	**Delivery Schedule**
Task 1 – Improve turbulence guidance from NWP forecasts	
a. Finalize code for RAPv2 for implementation at NCEP (ESRL, NCEP) Vigorous effort leading complete package with extensive improvements, summary at: **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2013.pdf**	Mar 2013 **COMPLETE**

Deliverables	Delivery Schedule
b. Complete the testing of the 40/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data (GSD, CAPS) Initial work completed by CAPS, testing of further enhancements to system. GSD testing and inclusion in RAPv2 of hybrid system with full observational data, using GFS ensemble data. Milestones exceed.	Mar 2013 **COMPLETE**
d. Report on early version of RAPv3 primary cycle at GSD with physics enhancements for initialization of the HRRR. (ESRL) Good progress with revised assimilation and WRFv3.5.1 as reported under Task 1. For more completeness, we request a delay to make this report by 30 January 2014. Complete - **http://ruc.noaa.gov/faa-mde/RAPv3-evaluation-15feb2014.pdf**	**Delay to Jan 2014** **COMPLETE**
e. Report on options for including satellite data in the RAP ensemble hybrid data assimilation to ensure overall positive impacts of the data (NCEP, ESRL) Complete - **http://ruc.noaa.gov/faa-mde/2014_AMS_Lin_EnKF-satellite-assim.pdf**	**Delay to Jan 2014** **COMPLETE**
f. Finalize RAP version to initialize experimental HRRR for 2014 real-time use toward operational HRRR (ESRL)	Mar 2014 **COMPLETE**
g. Deliver progress report on development of NARRE (NCEP, ESRL). Complete - http://ruc.noaa.gov/pdf/Benj_DTC_RAP-NARRE-Apr14.pdf	Mar 2014 **COMPLETE**
h. Deliver progress report on ensemble/hybrid data assimilation for use in NARRE (ESRL, NCEP). Complete - http://ruc.noaa.gov/pdf/WoF_RAP_hyb_01April2014_Hu.pdf	Mar 2014 **COMPLETE**
i. Subject to NCEP Directors' approval, upgrades to observation processing and/or quality control and/or GSI and/or NMMB systems become Operational at NCEP. (NCEP)	Mar 2014 Status: planned for 13 May 2014
j. Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. (NCAR-MMM)	Mar 2014 **COMPLETE**

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE
GSD

In March, intense testing and evaluation of the GSD HRRR and RAP continued, leading to a frozen upgrade package for the 2014 warm-season evaluation and representing a successful satisfaction of the task deliverable. Numerous changes were made to both systems, resulting in improvements to most forecast elements. For the RAP (which initializes the HRRR), these improvements are over the RAPv2, which was recently implemented as an operational upgrade at NCEP, are represent a prototype RAPv3. For the HRRR, the changes are over the previous GSD HRRR, which was frozen for the 2013 warm-season evaluation. A comprehensive document detailing all the changes can be found at:

http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf

With the exception of HRRR data assimilation change (2) (use of the GSI hybrid assimilation), most of the HRRR model and assimilation changes listed in this document will be included in the NCEP operational HRRR implementation scheduled for 19 Aug. 2014.

Within the recent GSD combined RAP / HRRR upgrade, changes that are especially significant for convection include:

1) RAP -- Changes to the Grell-Freitas (GF) convective parameterization scheme (from an older Grell scheme). The scheme is designed to become less active as the grid size reduces to cloud-resolving scales with enhanced shallow cumulus parameterization. A tighter fit to upper-level observations can be expected at the analysis time

and throughout the forecast period from improved convective forecasts. Improved precipitation forecasts can also be expected with a reduction in high bias of lower precipitation amounts (less than a half inch in a six hour period) and an improved bias of higher precipitation amounts (more than a half inch in a six hour period).

2) RAP and HRRR -- Enhanced the assimilation of surface dewpoint observations by accounting for the difference between the height of the lowest model level (~8 m AGL) and the height of the surface observation (2 m AGL). A reduction in moist bias of lower level relative humidity through the forecast period can be expected.

3) HRRR -- Adjusted the assimilation of radar reflectivity-derived latent heating at 15min intervals through a 1-hour pre-forecast period by lowering the threshold for specification of latent heating from 35 dBZ to 28 dBZ and reducing the magnitude of the latent heating for a given reflectivity by a factor of four. The changes represent a broadening and weakening of the forcing applied from radar reflectivity observations to slightly reduce excessive convective storm development at the beginning of a HRRR forecast run.

4) HRRR -- Enabled GSI hybrid data assimilation with model background error covariances now including 75% from a flow (weather) dependence derived from a GFS 80member ensemble forecast at 60-km using the Ensemble Kalman Filter in combination with 25% static 3D model background error covariance to improve the assimilation of all observations. A slightly tighter fit to upper-level observations at the analysis time and throughout the forecast period can be expected.

This set of changes has resulted in overall forecast improvement for the GSD RAP and HRRR, including HRRR forecasts of convective events. Consistent with this, recent real-time GSD HRRR forecasts have shown very good skill at depicting details of convective events (including near-county scale locations of storm clusters and line gaps) with several hours of lead-time. Fig. 1 below shows an example of such a forecast, a 5-hour forecast of a broken line of storms stretching from Michigan to Iowa to northeast Kansas.

Work also continued toward the HRRR operational implementation at NCEP (scheduled for 19 Aug 2014). In March, progress was made on reducing the run-time, with the overall hourly cycle time very near the target time of one hour. Recent work has focused on updating the control scripts to conform to NCO requirements.

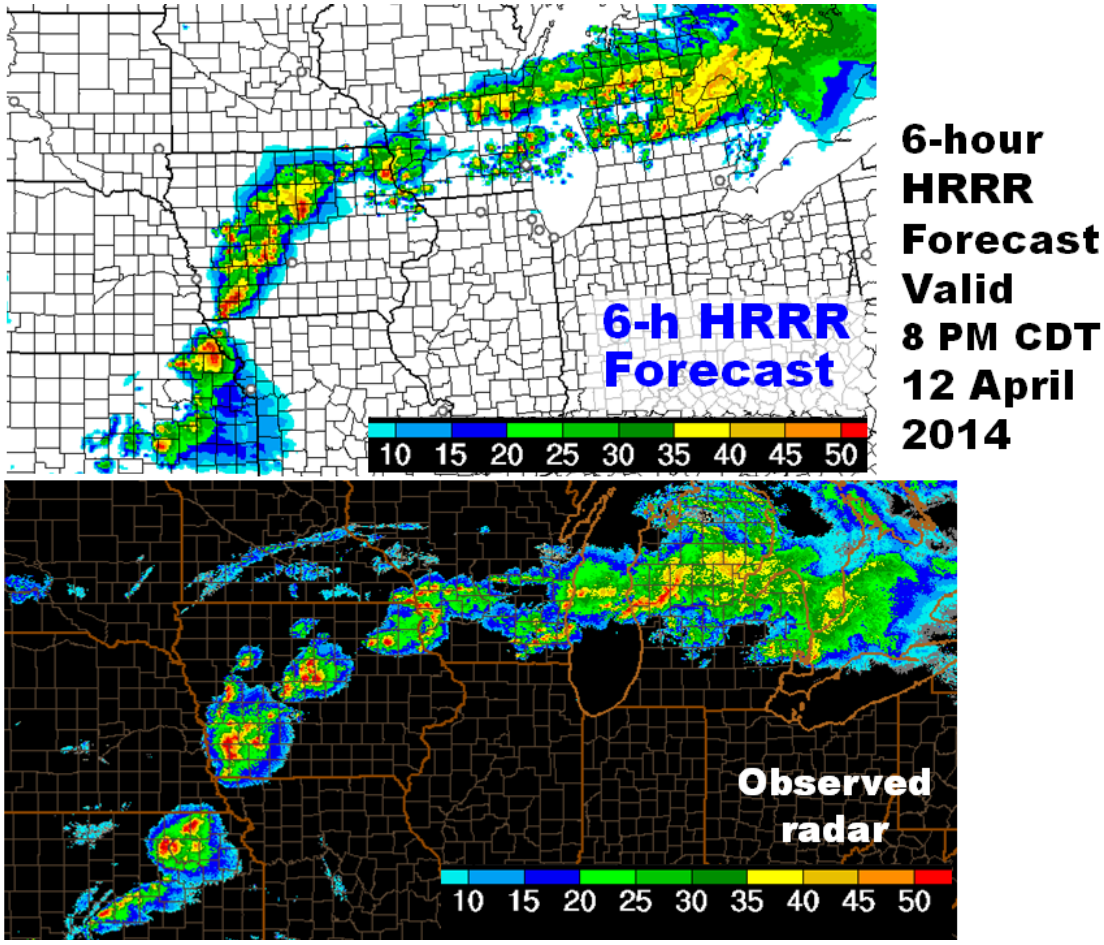

Fig. 1. Comparison of HRRR 5-h forecast reflectivity and radar observed reflectivity for 8 PM CDT 12 April 2014.

NCEP

NCEP EMC and NCO conducted a planning exercise of what the modeling suite might look like at the projected end stage of the Weather and Climate Operational Supercomputing System (WCOSS) Phase 1 (~2015) and Phase 2 (~2018). There is a possible delay in delivery of the Phase 2 upgrade. IBM is considering selling their division that sells and supports the iDataplex clusters like WCOSS. The problem is they are considering selling it to Lenovo, which is a Chinese company, and NCEP cannot have a computer that is sourced from China. Discussions are occurring at the highest levels of IBM & NOAA, but it is not clear when a resolution to the issue will be reached.

NCEP & ESRL

The computing resources on NOAA R&D machine Zeus are being used by ESRL/GSD to run HRRR which together with the primary run on Jet comprise a 98.3% reliable source for HRRR.

Deliverables	Delivery Schedule
Task 2 – Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	
a. Report on initial tests of 3-km 15-min RTMA cloud / surface analysis for use in frontal diagnostics, CI assessment and other near-surface assessments (ESRL, NCEP) *Good progress toward 3km RTMA and RUA surface and cloud analyses* *Successful initial tests summarized in report:* **http://ruc.noaa.gov/pdf/GSD_RTMA_report.pdf**	Feb 2013 **COMPLETE**
b. Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for 2013 real-time use (ESRL) *Extensive set of enhancements in place and running in real-time experimental GSD RAPv2 / HRRR system*	Mar 2013 **COMPLETE**
c. Provide preliminary 15-min RTMA surface analyses as experimental improved basis for frontal diagnostics and other diagnostics from surface analyses (ESRL, NCEP) **Prototype HRRR-based 15-min RTMA analysis completed with sample grids and graphics.**	Aug 2013 **COMPLETE**
d. Report on computing resource status on NCEP Central Computing System, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR (NCEP, ESRL) See above discussion concerning ~2014 implementation and Task 4	**June 2013** **COMPLETE**
e. Complete FY13 internal assessment with revised 3-km HRRR running every hour (ESRL) **Assessment complete with very good results seen for 2013 HRRR in objective and subjective verification and high run reliability**	Sept 2013 **COMPLETE**
f. Provide revised 15-min RTMA surface analyses as primary basis for frontal diagnostics and other diagnostics from surface analyses for real-time use in 2014 (ESRL, NCEP). **Real-time 15-min RTMA running with grids available on ftp**	Feb 2014 **COMPLETE**
g. Finalize all changes to the HRRR for real-time use in 2014 (ESRL) Report in **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf**	Mar 2014 **COMPLETE**

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

The RAPv2 physical parameterization configuration resulting from test and evaluation of physics options during the late 2012 – early 2013 period and described in previous reports was part of the RAPv2 implementation on 25 February 2014:

- New 9-level configuration of the RUC land-surface model (RUC LSM) with fix to canopy evaporation when the MYNN surface layer is used.
- Mellor-Yamada-Nakanishi-Niino (MYNN) planetary-boundary- and surface-layer scheme (modified considerably by Joe Olson) in place of the Mellor-Yamada-Janjic (MYJ) scheme used in RAPv1.
- Continue use of the Grell G3 scheme from WRFv3.2.1.
- Continue use of the Goddard short wave and RRTM long-wave radiation schemes.
- Use WRFv3.4.1 version of the Thompson microphysics.

Looking toward a mid-late March code freeze for the RAPv3 and HRRRv2 for summer 2014, intensive effort continued for much of the quarter toward arriving at the final version of the RAPv3 physics configuration. Nearly all the RAPv3 changes were introduced into the GSD RAP-primary at 0600 UTC 12 March, with final changes being introduced at 1700 UTC 5 April. Below are listed the main features of this suite and significant changes from RAPv2. Because of the need to complete evaluation of HRRR performance with the new version 3 of it's parent RAP, HRRR changes were completed a bit later, with the final GSD HRRR configuration for the 2014 convective season being introduced at 0300 UTC 10 April. Except for the absence of parameterization of deep and shallow convection in the HRRR, the RAP and HRRR physics

suite is identical. A complete list of all changes is given at http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2014.pdf.

- Long and short wave versions of RRTMG. In addition to provision for attenuation of solar radiation by aerosol, RRTMG has a more rigorous accounting for the attenuation of solar radiation by ice and snow recently developed by Greg Thompson. Although RRTMG has available a semi-empirical diagnostic cloud fraction calculation, an alternative, being examined by Joe Olson, is direct coupling with the shallow convection component of the Grell-Freitas convection (see below). Because the RRTMG is more expensive, it will be called every 20min instead of every 10. Compensating for this, the "swint" option in the WRF model namelist (available with the recent WRFv3.5.1) has been activated, so that at each time step in which radiation is not called; the incoming solar radiation is adjusted to correspond to the current solar zenith angle. In this adjustment, no account is taken of changes in cloud cover since the last call to the radiation; NCAR is working on this enhancement under other-agency funding. This enhancement will likely become available later in 2014.
- RUC LSM (9-level version) changes. These include 1) treatment of albedo in situations of partial snow cover, which itself must be parameterized, 2) reduction of surface roughness in areas of snow cover over tundra, scrubland and cropland (earlier testing on this was mostly done with the MYJ PBL and surface layers). See further discussion below, 3) further considerations of the representation of snow melt in low-level warm-advection conditions typical of spring. During the quarter retrospective experimentation and real-time evaluation produced a significant reduction of the cold bias over snow (see below). In addition, Tanya Smirnova obtained MODIS satellite-derived greenness fraction leaf-area index (LAI) fields to be made available with the WRFv3.6 release. Her evaluation of the impact of these fields relative to the current specification of leaf-area index in the RUC LSM was favorable toward including the more direct (but still climatological) MODIS specification of LAI.
- Further upgrades to the MYNN surface and boundary layer schemes. See further discussion below on this. These address two systematic biases that were not completely eliminated in RAPv2: the nighttime cold bias over snow cover noted above in conjunction with the RUC LSM, and the daytime warm and dry bias at the surface we see with the RAPv2 under clear skies, particularly during the warm season. Of the two, the cold bias over snow is the most egregious and received the most attention during the quarter. After extensive testing on individual cases and in the real-time ongoing RAP-dev2 cycle on Zeus, we decided to decrease surface thermal roughness over snow cover in order to decrease coupling of the atmosphere close to the ground with the ground itself, and under very stable conditions to increase the mixing within the atmosphere itself. But, the most effective change toward reducing the cold bias has been to increase the thickness of the top layer of snow. For very stable conditions we have also modified the stability function assumed in the WRF procedure for diagnosing 2-m temperature from the predicted temperature in the lowest model layer (considered to be near 8m AGL) and model-predicted skin temperature. All these changes have served to significantly reduce (but not entirely eliminate) the cold bias over snow cover in clear nighttime conditions.
- Replacement of the G3 convection scheme used in RAPv1 and RAPv2 by the Grell-Freitas deep and shallow scheme. Georg Grell was successful in improving precipitation prediction by the Grell-Freitas (G-F) convection scheme as validated using the May 2012 retrospective period. The decision was made in late January to finally replace the old WRFv3.2.1 version of the G3 scheme with this improved version of G-F. It has since continued to perform well in the real time RAP cycles.

  The fair-weather, warm-season warm / dry bias noted above appears to have been greatly reduced by the use of the simple relative-humidity based partial cloudiness parameterization in the RRTMG short-wave scheme together with the G-F shallow convection, and so we have incorporated this as part of RAPv3. As we transition to the warm season we will be watching to see if this promise of improved performance holds up. Although Joe Olson working with Grell converted the G-F shallow convection component to run as a stand-alone routine in WRF so that it could be used in the HRRR, testing in the HRRR has heretofore not given good results, Further development and testing of this scheme will be necessary before it can be considered suitable for the HRRR.

- Continued use of the NCAR Thompson microphysics. This continues to work well in the context of other changes for RAPv3.

Further activities:

- New aerosol-aware microphysics from NCAR. On 15 Feb, Greg Thompson notified GSD that the new aerosol-aware microphysics from NCAR became available as part of the WRFv3.6-pre-release. Now that the RAPv3 and HRRR-2014 codes are frozen for the CoSPA summer exercise, we expect to soon begin testing the aerosol-aware microphysics, first in the RAP. This will be combined with evaluation of the WRFv3.6 code release (together with a few RAP enhancements not yet in the NCAR WRF repository), scheduled for mid- April 2014.

NCAR/RAL

CURRENT EFFORTS: Final preparation steps were made with the aerosol-aware Thompson and Eidhammer (2014) microphysics scheme for integration and release into the public version of WRFV3.6 coming in April 2014.

FUTURE EFFORTS: NCAR-RAL will assist NOAA-GSD to adopt/utilize the new scheme. Trude Eidhammer will resume additional testing of the ice initiation by aerosols once new FY14 funding arrives.

PROBLEMS/ISSUES ENCOUNTERED: A gap in funding from end of FY13 to start of FY14 caused us to pause activity on this task. The integration of the aerosol-aware microphysics scheme depends on availability of NOAA-GSD personnel.

INTERFACE WITH OTHER ORGANIZATIONS: None.

NCAR/MMM

Deliver a WRF Users' Workshop and WRF Tutorial for the User Community

During this quarter NCAR gave a WRF tutorial in Boulder on January 27–31. This covered the basic WRF system, and approximately 60 people attended. In February (24–27) NCAR also delivered a tutorial at the University of New South Wales in Sydney, Australia on Feb. 24–27. This covered the basic WRF system and was followed by a WRF workshop. There were 63 tutorial attendees.

NCAR began organizing the 2014 WRF Users' Workshop, and issued the announcement and call for papers. The workshop will be held at NCAR's Center Green facility in June. The topic for the modeling basics series this year will be WRF best practices, while the core of the workshop will feature three days of talks on developments in the various areas of the system (e.g., physics, DA, real-time applications). The final day will offering mini-tutorials.

PLANNED EFFORTS: NCAR will host the WRF Users' Workshop June 23–27, 2014. NCAR will organize and lead the next WRF tutorial in July 2014.

UPDATES TO SCHEDULE: NONE

Incorporate Physics and Dynamics Improvements into WRF

NCAR led the oversight of preparations of the next major release, WRF V3.6. NCAR held regular meetings of the Release Committee and issued two friendly-user releases, in February and March. WRF V3.6 will be released in April, and details on it may be found at: **http://wrf-model.org/users/release.php**.

Jimy Dudhia (NCAR/MMM) worked with Ming Chen (NCAR/MMM) in the preparation of codes for the V3.6 release. They set up the system to have a new lake model in WRF work with a WPS-provided lake mask and lake depth. They also obtained lake depth data for WPS and worked on initializing lake temperature profiles. Dudhia and Chen also resolved a problem with parallelization in the new SBM microphysics scheme and worked on sea ice with both the new lake model for V3.6 and the new surface layer scheme, sfclayrev. They also implemented updated code from UCLA for the SSiB LSM related to producing 10-m winds.

Dudhia also worked with A.-J. Deng and Dave Stauffer (Penn State) on their testing of the PSU shallow convection scheme for WRF. Based on their case studies, Deng and Stauffer identified problems related to non-repeatable results. The PSU shallow convection scheme will be a candidate for implementation in WRF after V3.6. In other cumulus physics work, Dudhia collaborated with Roman Pilon (Univ. of Miami) to evaluate MJO behavior with a modified Tiedtke cumulus scheme.

Dudhia worked with Stefan Tulich (NOAA) to resolve issues with conservation in the WRF vertical diffusion formulation. The scheme currently uses mu (μ) in calculations, although it should more accurately use density. They are working on a modification, and the change will most likely be released in WRF V3.6.1.

Dudhia consulted with Pedro Jimenez (CIEMAT, Spain) in an evaluation of WRF surface winds against ocean wind observations. The observational comparisons found different PBL schemes to have similar biases, and they found

improvements to the stress formulation to reduce the biases. This work is being finalized with a new formula for surface roughness in shallow water, and will be written up for publication.

Dudhia also consulted with Jimenez on final changes to the wind-farm parameterization for V3.6. The changes improve the way the turbines characteristics and locations can be defined, as well as simplifying the idealized set-up and making it more like a physics namelist option in WRF.

Dudhia consulted with Jose Ruiz-Arias (Univ. of Jaen, Spain) on his method of providing high frequency solar irradiance output with the effect of clouds. This involves a simple surface radiation model to interpolate between radiation steps, and combining this with empirical cloud effects.

Dudhia worked with Feng Chen (visitor from Zhejiang Institute of Meteorological Sciences, Hangzhou, China), Ming Chen (NCAR/MMM), and Changhai Liu (NCAR/RAL) in comparing LSM options in WRF.
Feng Chen has done a comparison study of regional climate snow prediction in the western US for three land models, CLM, NoahMP, and Noah. He has confirmed that CLM and NoahMP both have significant strengths and skill relative to the older Noah model.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RAP and HRRR will continue through this quarter.

UPDATES TO SCHEDULE: NONE

Deliverables	**Delivery Schedule**
Task 3 – Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	**Delivery Schedule**
Conduct initial single test of aerosol-aware microphysics in ARW in a RAP configuration as start of a 2014 evaluation for its suitability as part of the RAPv3 prototype for 2015 NCEP implementation (NCAR-RAL, ESRL) This task name has been changed to accurately reflect the long-term evaluation needed for this complicated change over much of 2014.	Will be completed in May-July in GSD testing of WRFv3.6.
b. Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package to be implemented at NCEP by spring 2014 (ESRL, NCEP) Freeze of model physics code for March 2013 version of RAP at ESRL allows this milestone to be met.	Mar 2013 **COMPLETE**
c. Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v2 software to NCO (NCEP, ESRL)	**Sept 2013 COMPLETE**
d. Transfer upgraded coupled aerosol-microphysics scheme into a test version of HRRR (NCAR-MMM, ESRL) COMPLETE – 15 Feb 2014 – see report above - RAL has made available aerosol-aware microphysics to GSD.	Dec 2013 **COMPLETE**
f. Finalize microphysics changes and other physics changes to improve icing forecasts for ESRL version of RAP and HRRR for 2014 real-time use (ESRL)	Mar 2014 **COMPLETE**
g. Report summary of icing probability skill measures by quarter for the year. (NCEP)	Mar 2014

Task 4: Develop convection-ATM-specific improvements for guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

Task 4 – Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use (ESRL)

Current:

A retrospective period from 15-31 May 2013 has been established for evaluation of model and data assimilation changes for the 2014 version of the ESRL RAP and HRRR. A control run for the retrospective period was completed using the 2013 ESRL RAP and HRRR versions but also included an adjustment in soil temperature and moisture and a correction in the RUC land surface model to remove unrealistic surface evaporation flux in areas of precipitation that were not available during the real-time runs in early May 2013. The code for the WRF-ARW version 3.5.1 update including changes to the Thompson microphysics scheme and associated reflectivity, VIL and echo top diagnostics has been merged with the ESRL RAP and HRRR WRF-ARW code base. RAP retrospective runs with WRF-ARW version 3.5.1 and data assimilation changes have been completed for the May 2013 period along with upper-level, surface and precipitation forecast verification comparison to the control run. The experiments include new convective parameterization and radiation schemes and updates to the boundary layer and land-surface schemes with forecast improvements noted in the results when compared to the control run. A final HRRR retrospective run has been executed including the WRF-ARW version 3.5.1 model changes for the HRRR and using the RAP retrospective run for initial and boundary conditions. The reflectivity forecast verification was executed for this final HRRR retrospective run with results showing nearly identical CSI (critical success index) values with an improved (reduced) bias noted at nearly all lead times when compared with the control run. This result indicates more accurate forecasts with less over-forecasting and more accurate locations of forecasted convective storms. A complete report on the evaluation of revised WRFv3.5.1 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL) is available at: **http://ruc.noaa.gov/pdf/GSD_reflectivity_report_2014.pdf.** A report on final retrospective testing for the ESRL HRRR-2014 is available at: **http://ruc.noaa.gov/pdf/GSD_HRRR_report_2014.pdf**.

Planned:

The ESRL RAP and HRRR real-time model configurations will remain frozen for the CoSPA season beginning on 17 April 2014 and concluding on 31 October 2014.

Task 4 – Assess HRRR reliability and provide monthly reporting (ESRL)

HRRR Reliability for 0-8 Hour VIL/Echo Tops for January 2014

Jet
All runs: 80.2%
3 or more consecutive missed runs: 94.2% (most meaningful for CoSPA)
6 or more consecutive missed runs: 95.8%
6 outages of at least 3 hrs. or longer
3 outages of at least 6 hrs. or longer

Zeus
All runs: 40.5%
3 or more consecutive missed runs: 47.0% (most meaningful for CoSPA)
6 or more consecutive missed runs: 51.1%
15 outages of at least 3 hrs. or longer
7 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 87.1%
3 or more consecutive missed runs: 94.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 96.2%
5 outages of at least 3 hrs. or longer
3 outages of at least 6 hrs. or longer

HRRR Reliability for 0-8 Hour VIL/Echo Tops for February 2014

Jet
All runs: 98.4%

3 or more consecutive missed runs: 99.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 100.0%
1 outages of at least 3 hrs. or longer
0 outages of at least 6 hrs. or longer

Zeus
All runs: 0%
3 or more consecutive missed runs: 0% (most meaningful for CoSPA)
6 or more consecutive missed runs: 0%
1 outages of at least 3 hrs. or longer
1 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 98.4%
3 or more consecutive missed runs: 99.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 100.0%
1 outages of at least 3 hrs. or longer
0 outages of at least 6 hrs. or longer

HRRR Reliability for 0-8 Hour VIL/Echo Tops for March 2014

Jet
All runs: 79.2%
3 or more consecutive missed runs: 93.5% (most meaningful for CoSPA)
6 or more consecutive missed runs: 98.1%
16 outages of at least 3 hrs. or longer
3 outages of at least 6 hrs. or longer

Zeus
All runs: 3.8%
3 or more consecutive missed runs: 5.4% (most meaningful for CoSPA)
6 or more consecutive missed runs: 8.2%
5 outages of at least 3 hrs. or longer
4 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 80.5%
3 or more consecutive missed runs: 94.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 98.1%
15 outages of at least 3 hrs. or longer
2 outages of at least 6 hrs. or longer

****** NOTE: During January – March, Zeus was used extensively for HRRR development testing and not as a backup capacity.***

Under Task 4 – Complete implementation of refined cloud-top cooling (GOES-CTC, formerly known as SatCast) assimilation for HRRR for real-time use in 2014

Tracy Smith continued her work with the assimilation of GOES-CI cloud-top cooling radar data within the RAP. Following her initial experiments she has completed an additional retrospective experiment using a higher cooling rate threshold and successfully removed some of the false alarms (see Fig. 2 below), resulting in slight higher skill scores. Recent work has focused on two areas: 1) Completion of sub-task for inclusion of a real-time feed of satellite data into a development parallel RAP version. This will be evaluated for a multi-day period. 2) preparatory work to evaluate the forecast impact from assimilation of the data in the 3-km HRRR.

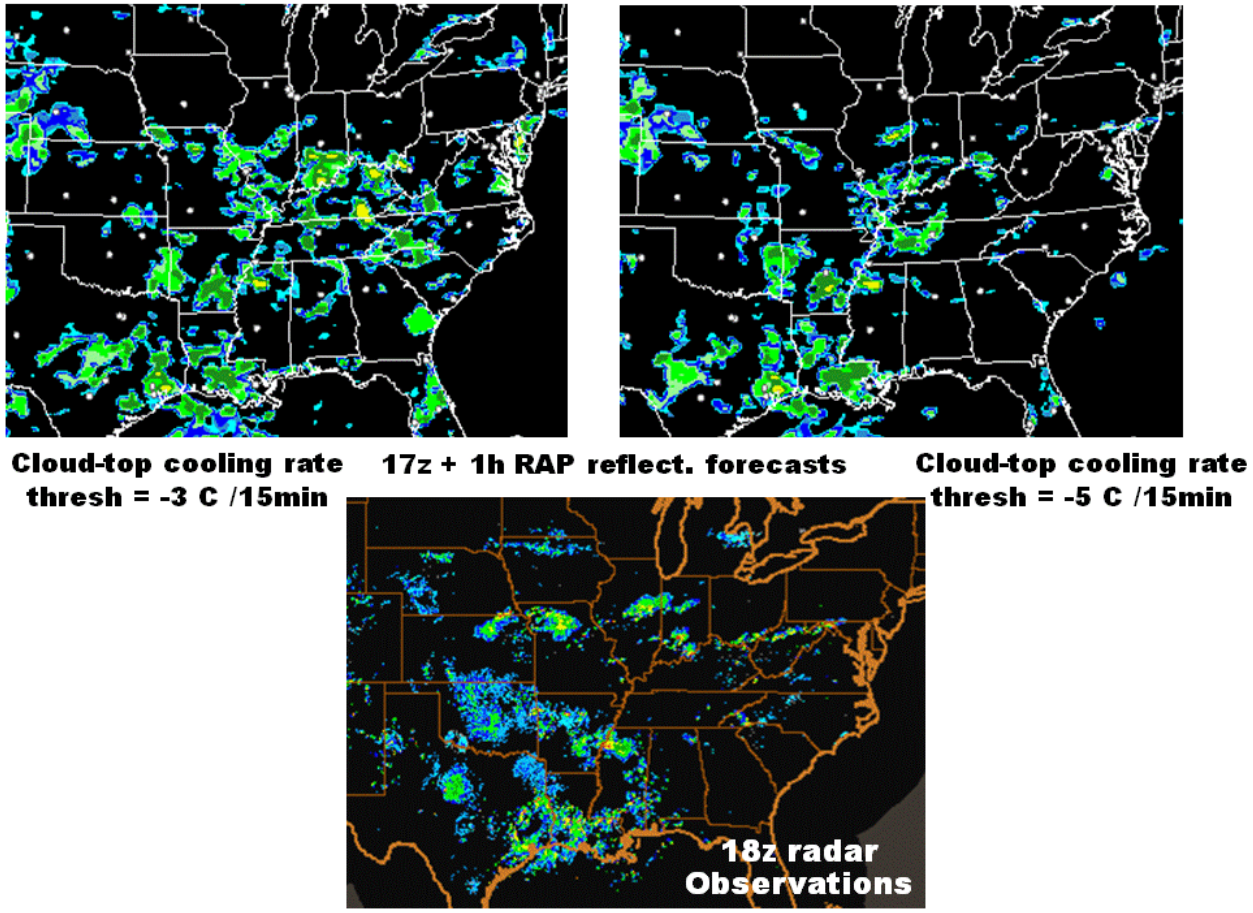

Fig. 2. Comparison of RAP 1-h forecasts valid 18z 8 July 2012 with assimilation of satellite-based cloud-top cooling rate data using a minimum threshold a -3 deg. C per 15 min. (left) and -5 deg. C per 15 min (right). Comparison with the radar observations (bottom) illustrates the reduction in spurious convection associated with the more restrictive -5 deg. threshold (right).

Also Under Task 4 – Interact with CoSPA (or other) program partner labs and the FAA

Team (ESRL/GSD, NCAR/RAL, and MIT/LL) telecons and e-mail correspondence will continue to occur during the CoSPA offseason regarding upcoming HRRR changes. CoSPA planning telecons were conducted on 11 February and 10 March with MIT/LL, NCAR and the FAA sponsor to discuss the upcoming changes to the HRRR model prior to the ~~01~~ 17 April 2014 CoSPA demonstration start. This discussion included both ESRL RAP and HRRR data assimilation and model changes. Additionally, HRRR model output format changes were discussed that will require a change at NCAR for CoSPA blending. An update on the HRRR operational implementation schedule at NCEP and HRRR failover between the two NOAA R&D high performance computer systems were also discussed. A follow-up planning telecon was held on 07 April 2014 to provide more detailed information regarding the upcoming HRRR changes. Discussion with MIT/LL continues regarding possible collaboration on convective weather avoidance polygons including the potential for feedback on the evolution of the size distribution of forecasted convective structures in the HRRR.

Deliverables	Delivery Schedule
Task 4 – Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA	
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL) Code for revised echo-top / reflectivity diagnostics with revised microphysics implemented in GSD real-time HRRR.	Mar 2013 **COMPLETE**
Conduct baseline testing of the early 2013 HRRR version (ESRL) Baseline testing of 2013 HRRR version completed as part of code preparation for freeze. Summary of skill score improvements being prepared.	Mar 2013 **COMPLETE**
Report on evaluation of new microphysics scheme and associated echo-top and reflectivity diagnostics in ESRL/GSD RAP and HRRR (ESRL) *Preliminary evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_reflectivity_report.pdf**	Mar 2013 **COMPLETE**
Assess HRRR reliability and provide monthly reporting (ESRL) Reliability statistics are being reported each month	*Apr 2013* **COMPLETE** *(ongoing)*
Report on evaluation of revised WRFv3.5.1 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL) *Evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_reflectivity_report_2014.pdf**	Mar 2014 **COMPLETE**
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use of HRRR (ESRL)	Mar 2014 **COMPLETE**
Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014 (ESRL) **Temporary installation in a parallel development RAP will occur in April.**	Mar 2014 **Good progress**
Report on 2014 baseline testing of the HRRR (ESRL) *Evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_HRRR_report_2014.pdf**	Mar 2014 **COMPLETE**